CLAIM AMENDMENTS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A motion estimation method for estimating a motion vector between a reference image frame and a current image frame, each of said reference frame and said current frame being formed by a plurality of pixels, the method comprising the steps of:

(a1) dividing a reference frame into a plurality of reference macroblocks, each of the plurality of reference macroblocks comprising a plurality of adjacent pixels within said reference frame, a set of said reference macroblocks forming a search range;

(a2) dividing at least one current frame into at least one current macroblock comprising a plurality of continuous pixels from said current frame, each of said reference macroblocks and said at least one current macroblock having generally ~~the~~ a same size and shape with a corresponding pixel distribution;

(a3) determining a similarity of one of said reference macroblocks and a selected one of said at least one current macroblock based on ~~averages of every two adjacent pixels as a pixel unit~~ calculated pixel units in said selected current macroblock and one of said reference macroblocks, wherein one calculated pixel unit comprises an average of two adjacent pixels;

(a4) repeating step (a3) for all of said reference macroblocks in said search range; and

(a5) determining a motion estimation of said current frame and said reference frame based on said respectively determined similarity in steps (a3) and (a4).

2. (Currently amended) The method of claim 1 further comprising ~~the steps of~~:

calculating an absolute difference of ~~a~~ each calculated pixel unit ~~for every two adjacent pixels~~ in said current macroblock and a corresponding calculated pixel unit ~~for every two adjacent pixels in~~ ~~said~~ one of the reference macroblocks resulting in a plurality of calculated absolute differences; and

summing said calculated absolute differences for all of said calculated pixel units ~~of~~ in said current macroblock.

3. (Currently amended) The method of claim 2 further comprising the step of determining a motion estimation vector between said selected current macroblock and a selected one of said reference macroblocks within said search range having a ~~smallest~~ smaller sum of said calculated absolute differences with said current macroblock than a sum of calculated absolute differences between said selected current macroblock and each other reference macroblock within said search range.

4. (Currently amended) The method of claim 1 further comprising ~~the steps of~~:

calculating a square of a difference between ~~of a~~ each calculated pixel unit ~~for every two adjacent pixels~~ in ~~selected~~ said current macroblock and a corresponding calculated pixel unit ~~for every two adjacent pixels~~ in one of said reference macroblocks resulting in a plurality of calculated squares of differences; and

summing said calculated squares of differences for all of said calculated pixel units of said current macroblock.

5. (Currently amended) The method of claim 4 further comprising ~~the step of~~ determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said search range having a smaller ~~smallest~~ sum of said calculated squares of differences with said current macroblock than another sum of calculated squares of differences between said current macroblock and each other of said reference macroblocks within said search range.

6. (Currently amended) The method of claim 1 further comprising ~~the steps of~~:

multiplying ~~a~~ each calculated pixel unit ~~for every two adjacent pixels~~ in said current macroblock with a corresponding calculated pixel unit ~~for every two adjacent pixels~~ in one of said reference macroblocks resulting in a plurality of multiplying values; and

summing all said multiplying values for ~~all of~~ said calculated pixel units in said selected current macroblock.

7. (Currently amended) The method of claim 6 further ~~comprises~~ comprising ~~a step of~~ determining a motion estimation vector between said selected current macroblock and one of

said reference macroblocks within said search range having a ~~largest~~ larger sum of said multiplying values than a sum of said multiplying values between said selected current macroblock and each other of said reference macroblocks within said search range.

8. (Currently amended) A motion estimation method for estimating a motion vector between a reference image frame and a current image frame, each of said reference frame and said current frame being formed by a plurality of pixels, the method comprising the steps of:

(b1) dividing a reference frame into a plurality of reference macroblocks, each of the plurality of reference macroblocks comprising a plurality of adjacent pixels within said reference frame, a set of said plurality of reference macroblocks forming a search range;

(b2) dividing a current reference frame into a current macroblock comprising a plurality of continuous pixels from said current frame, each of said reference macroblocks and said current macroblock having generally ~~the~~ a same size and shape with a corresponding pixel distribution;

(b3) determining a similarity of one of said reference macroblocks and said current macroblock based on ~~averages of every two adjacent pixels as a pixel unit~~ calculated pixel units in said current macroblock and a first determined set of said reference macroblocks[[;]], wherein one calculated pixel unit comprises an average of two adjacent pixels;

(b4) determining similarities for said first predetermined set of reference macroblocks in said search range for performing a coarse tune operation;

(b5) determining a preferred reference macroblock from said first predetermined reference macroblocks based on said similarities;

(b6) determining similarities for a second predetermined set of reference macroblocks around said preferred reference macroblock based on calculated pixel[[s]] units of said current macroblock and said second predetermined set of reference macroblocks for performing a fine tune operation; and

(b7) determining a motion estimation of said current frame and said reference frame from said determined similarities of step (b6).

9. (Currently amended) The method of claim 8 further comprising ~~the steps of~~:

calculating an absolute difference of a calculated pixel unit ~~for every two adjacent pixels~~ in said current macroblock and a corresponding calculated pixel unit ~~for every two adjacent pixels~~ in one of said reference macroblocks resulting in a plurality of calculated absolute differences; and

summing said calculated absolute differences for all pixels of said current macroblock.

10. (Currently amended) The method of claim 9 further comprising the step of determining a motion estimation vector between said current macroblock and one of ~~said~~ the reference macroblocks within said first predetermined set of said reference macroblocks having a smaller ~~smallest~~ sum of said calculated absolute differences than a sum of calculated absolute differences between said selected current macroblock and each other of said reference macroblocks.

11. (Currently amended) The method of claim 8 further comprising the steps of:

calculating an absolute difference of a pixel of said current macroblock and a corresponding pixel of one of said reference macroblocks resulting in a plurality of calculated absolute differences; and

summing said calculated absolute differences for all pixels of said current macroblock.

12. (Currently amended) The method of claim 11 further comprising the step of determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said second predetermined set of said reference macroblocks having a smaller ~~smallest~~ sum of said calculated absolute differences than a sum of calculated absolute differences between said selected current macroblock and each other of said reference macroblocks within said second predetermined set of said reference macroblocks.

13. (Currently amended) The method of claim 8, wherein the step (b3) further ~~comprising~~ comprises the steps of:

calculating a square of a difference between ~~of a~~ each calculated pixel unit ~~for every two adjacent pixels~~ in said current macroblock and a corresponding calculated pixel

unit ~~for every two adjacent pixels~~ in one of said reference macroblocks resulting in a plurality of calculated squares of differences; and

summing said calculated squares of differences for all calculated pixel[[s]] units in said current macroblock.

14. (Currently amended) The method of claim 13 further comprising ~~the step of~~ determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said first predetermined set of said reference macroblocks having a smaller ~~smallest~~ sum of said calculated squares of differences than another sum of calculated squares of differences between said current macroblock and each other of said reference macroblocks within said first predetermined set of said reference macroblocks.

15. (Currently amended) The method of claim 8 further comprising ~~the steps of~~:

calculating a square of a difference of a pixel of said current macroblock and a corresponding pixel of one of said reference macroblocks within said second predetermined set of said reference macroblocks resulting in a plurality of calculated squares of differences; and

summing said calculated squares of differences for all pixels of said current macroblock.

16. (Currently amended) The method of claim [[11]] 15 further comprising ~~the step of~~ determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said second predetermined set of said reference macroblocks having a ~~smallest~~ smaller sum of said calculated squares of differences with said current macroblock than another sum of calculated squares of differences between said current macroblock and another of said reference macroblocks within said second predetermined set of said reference macroblocks.

17. (Currently amended) The method of claim 8 further comprising ~~the steps of~~:

~~calculating a~~ multiplying ~~a~~ each calculated ~~value of a~~ pixel unit ~~for every two adjacent pixels~~ in said current macroblock and a corresponding calculated pixel unit ~~for every two adjacent pixels~~ in one of said reference macroblocks resulting in a plurality of calculated multiplying values; and

summing said calculated multiplying values for ~~all~~ said calculated pixel[[s]] units of said current macroblock.

18. (Currently amended) The method of claim 17, further comprising ~~the step of~~ determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said first predetermined set of said reference macroblocks having a ~~largest~~ larger sum of said calculated multiplying values than a sum of said multiplying values between said selected current macroblock and each other of said reference macroblocks within said first predetermined set of said reference macroblocks.

19. (Currently amended) The method of claim 8 further comprising the steps of:

calculating a multiplying value of a pixel of said current macroblock and a corresponding pixel of one of said reference macroblocks resulting in a plurality of calculated multiplying values; and

summing said calculated multiplying values for all pixels of said current macroblock.

20. (Currently amended) The method of claim 19, further comprising the step of determining a motion estimation vector between said current macroblock and one of said reference macroblocks within said second predetermined set of said reference macroblocks having a ~~smallest~~ smaller sum of said calculated multiplying values than a sum of said multiplying values between said selected current macroblock and each other of said reference macroblocks within said second predetermined set of said reference macroblocks.

21. (Original) The method of claim 1 wherein said reference frame and said current frame are formed by even lines and odd lines.

22. (Currently amended) The method of claim 21 further comprising ~~the step of~~ determining a top field motion estimation using pixels in said even lines.

23. (Currently amended) The method of claim 21 further comprising ~~the step of~~ determining a bottom field motion estimation using pixels in said odd lines.

24. (Original) The method of claim 8 wherein said reference frame and said current frame are formed by even lines and odd lines.

25. (Currently amended) The method of claim 24 further comprising ~~the step of~~ determining a top field motion estimation using pixels in said even lines.

26. (Currently amended) The method of claim 24 further comprising ~~the step of~~ determining a bottom field motion estimation using pixels in said odd lines.

27. (Currently amended) A motion estimation device ~~for reducing memory output bandwidth~~ comprising:

a memory having a frame buffer ~~for~~ to store ~~storing~~ a plurality of image frame data;

a controller ~~being connected~~ coupled to said memory, said controller ~~inputting and processing~~ including logic to receive and process data of a current image frame and a reference image frame, and ~~then outputting~~ to output processed data;

a first motion estimation processor ~~being connected~~ responsive to said controller for coarse-tuning motion estimation of said current image frame to said reference image frame based on said processed data ~~input~~ from said controller, the first motion estimation processor to determine a similarity of a reference macroblock and a current macroblock associated with an image from the plurality of image frame data, wherein the reference macroblock and the current macroblock each comprise multiple pixels, the first motion estimation processor to determine the similarity based on ~~averages of every two adjacent pixels as a~~ calculated pixel units in the current macroblock and a first determined set of calculated pixel[[s]] units of the reference macroblock, the first motion estimation processor to output coarsed-tuned data, wherein one calculated pixel unit comprises an average of two adjacent pixels; and

a second motion estimation processor ~~being connected~~ responsive to said controller and said first motion estimation processor for fine-tuning motion estimation of said current frame to said reference frame based on said processed data ~~input~~ from said controller and said coarse-tuned data ~~input~~ from said first motion estimation processor.

28. (Currently amended) The device of claim 27 wherein:

said controller ~~dividing~~ divides a plurality of reference macroblocks, each comprising a plurality of continuous pixels within said reference frame;

said reference macroblocks ~~forming~~ form a search range; and

said controller ~~dividing~~ divides a current macroblock comprising a second plurality of continuous pixels from said current frame;

wherein each of said reference macroblocks and said current macroblock has ~~the~~ approximately a same size and approximately a same shape, with a corresponding pixel distribution.

29. (Canceled)

30. (Original) The device of claim 28 wherein said second motion estimation processor determines a similarity of said reference macroblocks and said current macroblock based on every pixel in said reference macroblocks and said current macroblock.

31. (Currently amended) The device of claim 30 wherein said controller sends a difference ~~of~~ between every ~~two adjacent pixels~~ calculated pixel unit of each of said reference macroblocks and a corresponding calculated pixel unit of said current macroblock and a least significant bit of a sum of every ~~two adjacent pixels~~ calculated pixel unit of each of said reference macroblocks and the corresponding calculated pixel unit of said current macroblock to said second motion estimation processor.

32. (Currently amended) The device of claim 27 wherein shapes of said reference macroblocks and said current macroblock are approximately rectangular.

33. (Original) The device of claim 27 wherein said memory further comprises a dynamic random access memory (DRAM) and static dynamic random access memory (SDRAM).

34. (Currently amended) A motion estimation method comprising the steps of:

(a) displaying an image in a plurality of frames corresponding to a plurality of time periods; wherein each frame further comprises a given number of pixels, each pixel represented by two-dimensional abscissa and ordinate coordinates;

wherein each frame further comprises at least one macroblock having a lesser number of pixels than said given number of pixels of said frame;

wherein a current frame is one of said frames in a current time period of said plurality of time periods;

wherein said current frame further comprises at least one current macroblock having a lesser number[[,]] of pixels than ~~those~~ said given number of pixels of said current frame;

wherein a reference frame is one of said frames in a time period of said plurality of time periods prior to said current time period for said current frame;

wherein said reference frame further comprises at least one reference macroblock having a lesser number of pixels than ~~those~~ said given number of pixels of said reference frame;

(b) determining calculated pixel units ~~averaging two adjacent pixels~~ of said current macroblock, wherein one calculated pixel unit comprises an average of two adjacent pixels;

(c) repeating step (b) for all pixels of said current macroblock;

(d) determining calculated pixel units ~~averaging two adjacent pixels~~ of one macroblock of said reference macroblocks;

(e) repeating step (d) for all pixels of said one reference macroblock;

(f) subtracting each ~~said averaged pixels~~ calculated pixel unit of said current macroblock from a corresponding ~~said averaged pixels~~ calculated pixel unit of said one reference macroblock resulting in a plurality of differences;

(g) taking a plurality of absolute values for said differences resulting in a plurality of ~~absolutions~~ absolute values;

(h) summing said ~~absolutions~~ absolute values resulting in a SAD (sum of ~~absolutions~~ absolute values of differences);

(i) shifting abscissa and ordinate coordinates of said one reference macroblock by corresponding abscissa and ordinate shift values resulting in a shifted reference macroblock;

(j) determining calculated pixel units ~~averaging two adjacent pixels~~ of said shifted reference macroblock;

(k) repeating step (j) for all pixels of said shifted reference macroblock;

(l) subtracting ~~said~~ ~~averaged pixels~~ each calculated pixel unit of said current macroblock from a corresponding ~~said~~ ~~averaged pixels~~ calculated pixel unit of said shifted reference macroblock resulting in an additional plurality of differences;

(m) ~~taking~~ determining an additional plurality of absolute values for said additional differences resulting in an additional plurality of ~~absolutions~~ absolute values;

(n) summing said additional plurality of ~~absolutions~~ absolute values resulting in an additional SAD ~~(sum of absolutions of differences)~~;

(o) repeating steps (i), (j), (k), (l), (m) and (n) for each reference macroblock resulting in a plurality of additional SADs; and

(p) ~~taking a minimum~~ selecting a selected SAD ~~out of~~ ~~said~~ from a group comprising the SAD and said additional SADs, wherein the selected SAD has a smaller value than another of the group.

35. (Canceled)

36. (Original) The method of claim 34 wherein said reference frame and said current frame are formed by even lines and odd lines.

37. (Currently amended) The method of claim 36 further comprising ~~the step of~~ determining a top field motion estimation using pixels in said even lines.

38. (Currently amended) The method of claim 36 further comprising ~~the step of~~ determining a bottom field motion estimation using pixels in said odd lines.